PROJECT INDY: INFILL REIMAGINED

US DOE Solar Decathlon Design Challenge
Ball State University | College of Architecture & Planning
NEST - Near East Side Team
USF - Urban Single Family
Jury Presentation

U S DEPARTMENT OF ENERGY
SOLAR DECATHLON

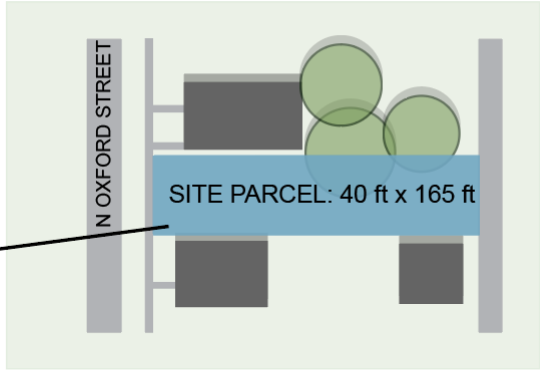
EXISTING SITE & CONTEXT

SITE DATA

- 225 N. Oxford St. Indianapolis, IN
- 40’ x 165’ Parcel / 6,400 Square Feet
- Maximum Elevation: 768
- Minimum Elevation: 765

DESIGN CONSTRAINTS

- 40 ft. wide parcel
- No driveway access from Oxford St.
- 5 ft. setbacks from lot line
- SDDC lot maximum: 5,000 sq. ft.



BUS STOP

① GROCERY

② CORNERSTONE LUTHERN CHURCH

③ ENGLEWOOD CHRISTIAN CHURCH

④ COMMUNITY GARDEN

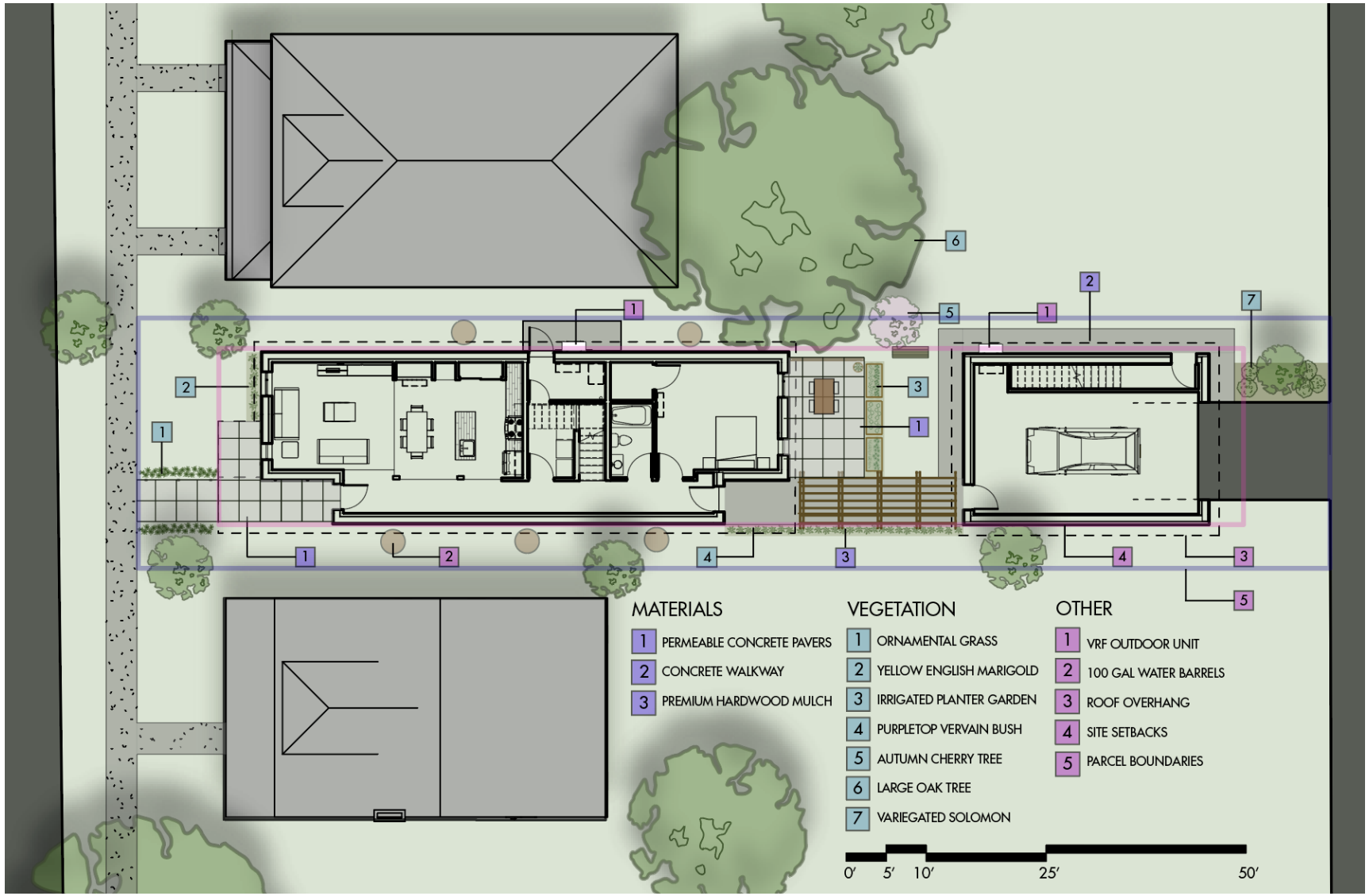
DESIGN CONSTRAINTS & GOALS

PROJECT GOALS

- An adaptable home to “age in place”
- Manage site water
- Provide passive solutions
- Model the use of CLT for affordable housing

SITE DESIGN

- Permeable concrete pavers, no steps on site
- Pergola for shading and privacy from adjacent neighbors
- Wood shading walls on front porch and back patio
- Concrete paving from home to the ADU
- Roof overhang on front porch for shading



ARCHITECTURE

FLOOR PLANS

First Floor

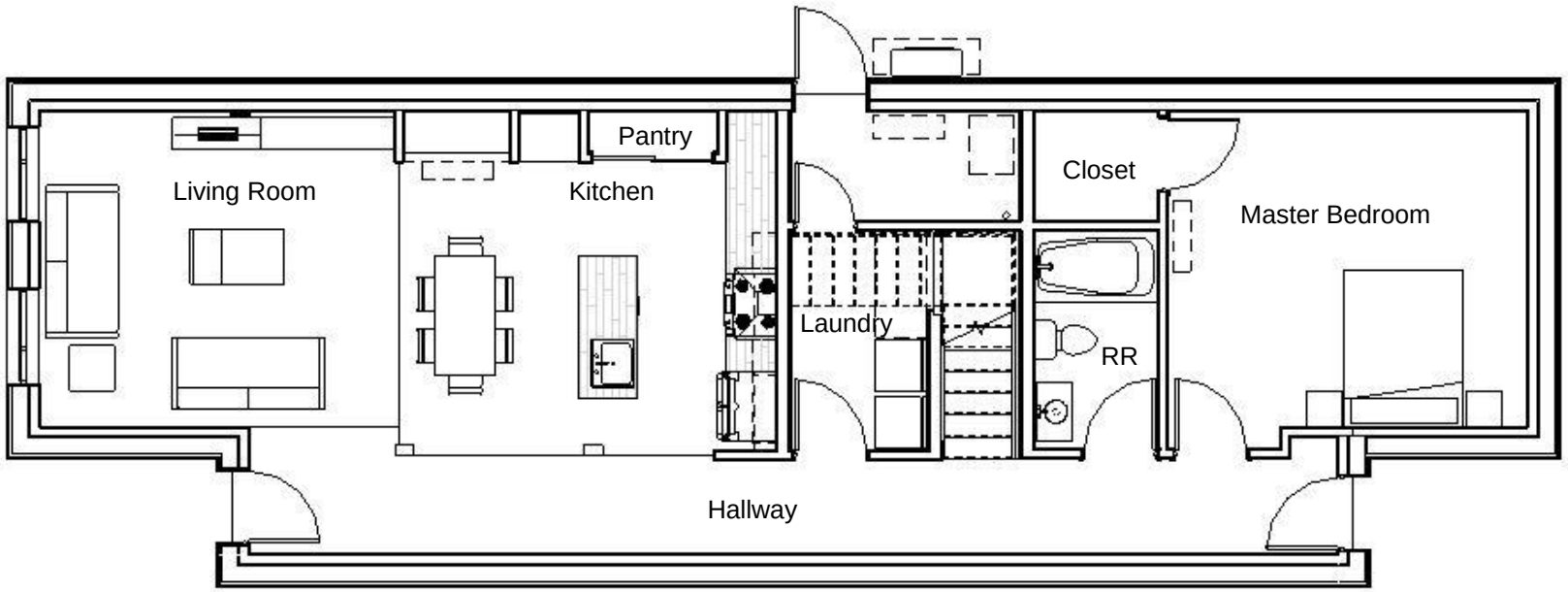
- Living Room
- Kitchen
- Utility Room
- Master Bedroom
- Full Bath

Second Floor

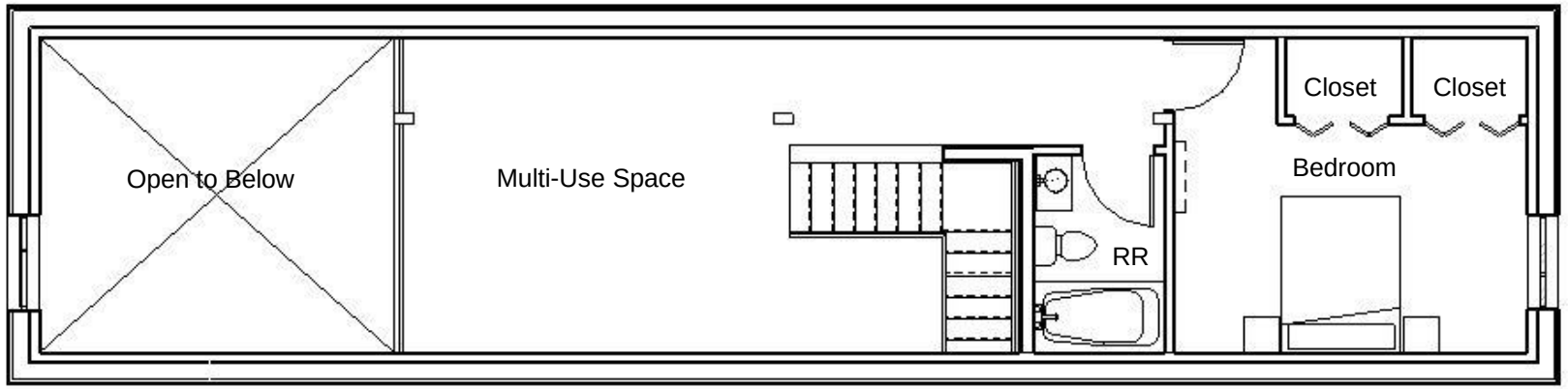
- Multi-Use Space
- Bedroom
- Full Bath

Spacious & Compact

- Double Height Living Space
- Limiting enclosed rooms
- Circulation open to living spaces



1st Floor Main House

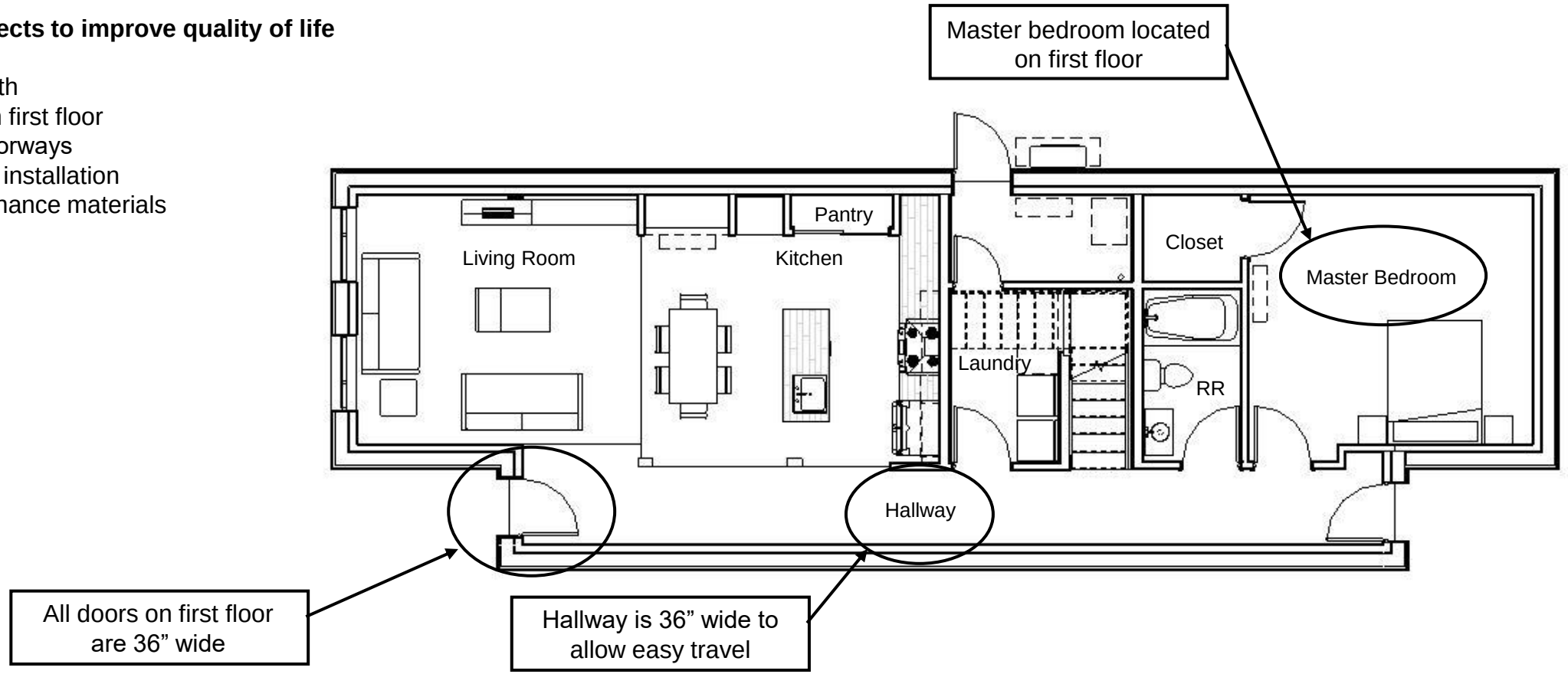


2nd Floor Main House

OCCUPANT EXPERIENCE

AGING IN PLACE

- **Architectural aspects to improve quality of life for seniors**
  - Hallway width
  - Bedroom on first floor
  - 36” wide doorways
  - Light switch installation
  - Low maintenance materials



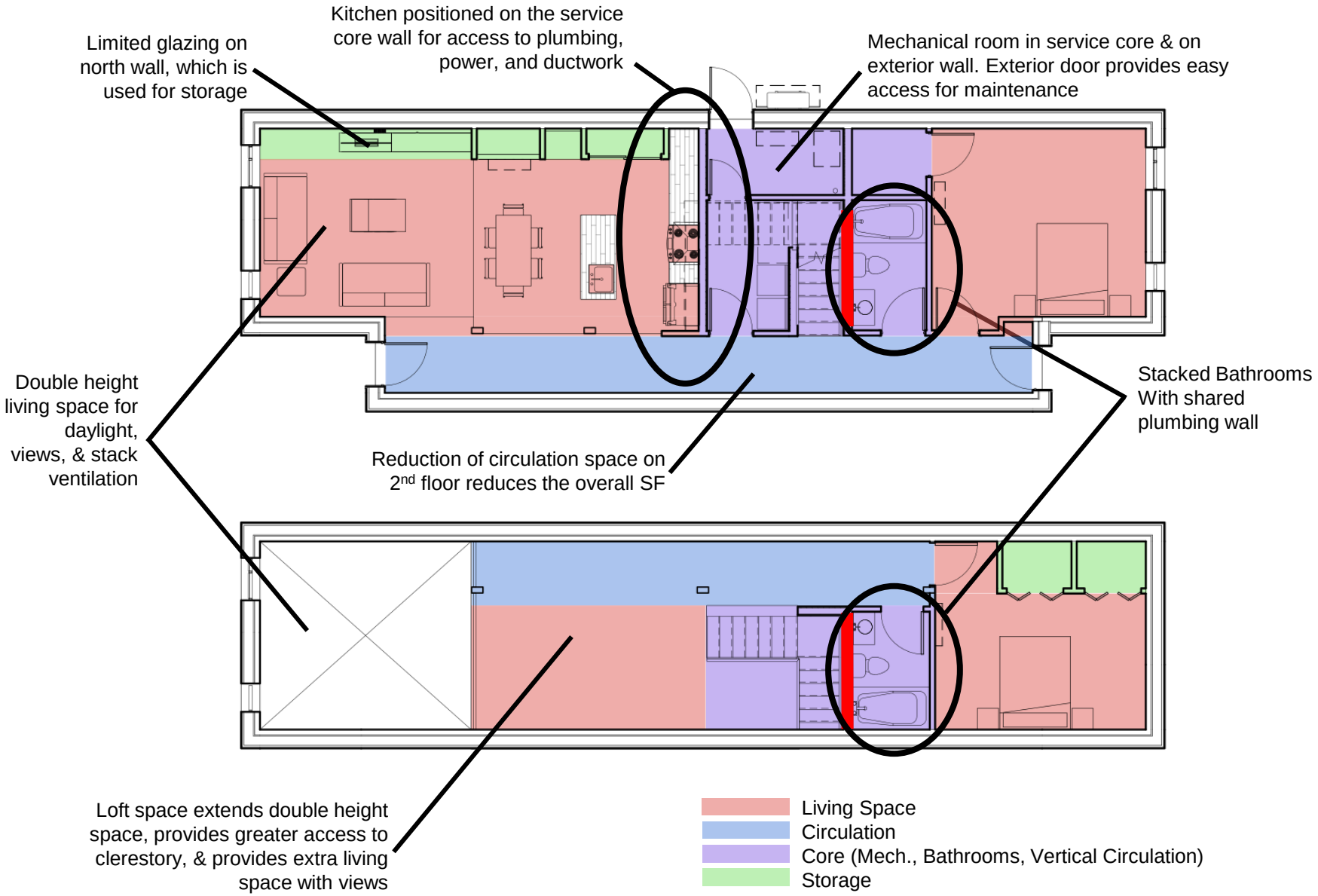
INTEGRATED PERFORMANCE

INTEGRATED SPACE

- One-Story South Hallway
  - Necessary for circulation
  - Tighten and release
  - Provides light and ventilation
- Tall Ceilings
  - Open room to more light
  - Makes space feel larger
- Saw-Toothed Roof
  - Architectural feature
  - Light/ Ventilation Access

FLOORPLAN

- Mechanical
  - Placed in core of house
  - Outside Access
- Living
  - Front (public space)
  - Back (private space)
- Storage
  - Along Northern wall



ARCHITECTURE

INTERIORS

- **Cork Flooring**
  - Warm, soft underfoot
  - Lower embodied impact than alternatives
  - Durable and water resistant with chosen finish
- **Butcherblock counters and shelves**
  - Compliments other wood textures throughout the home
  - Just as durable as alternatives with chosen finish
  - Low cost
- **Neutral colors**
  - The materials chosen should complement any furniture the occupants want in the home
- **Exposed CLT structure**
  - Shows how the home is put together and shows off the wood texture

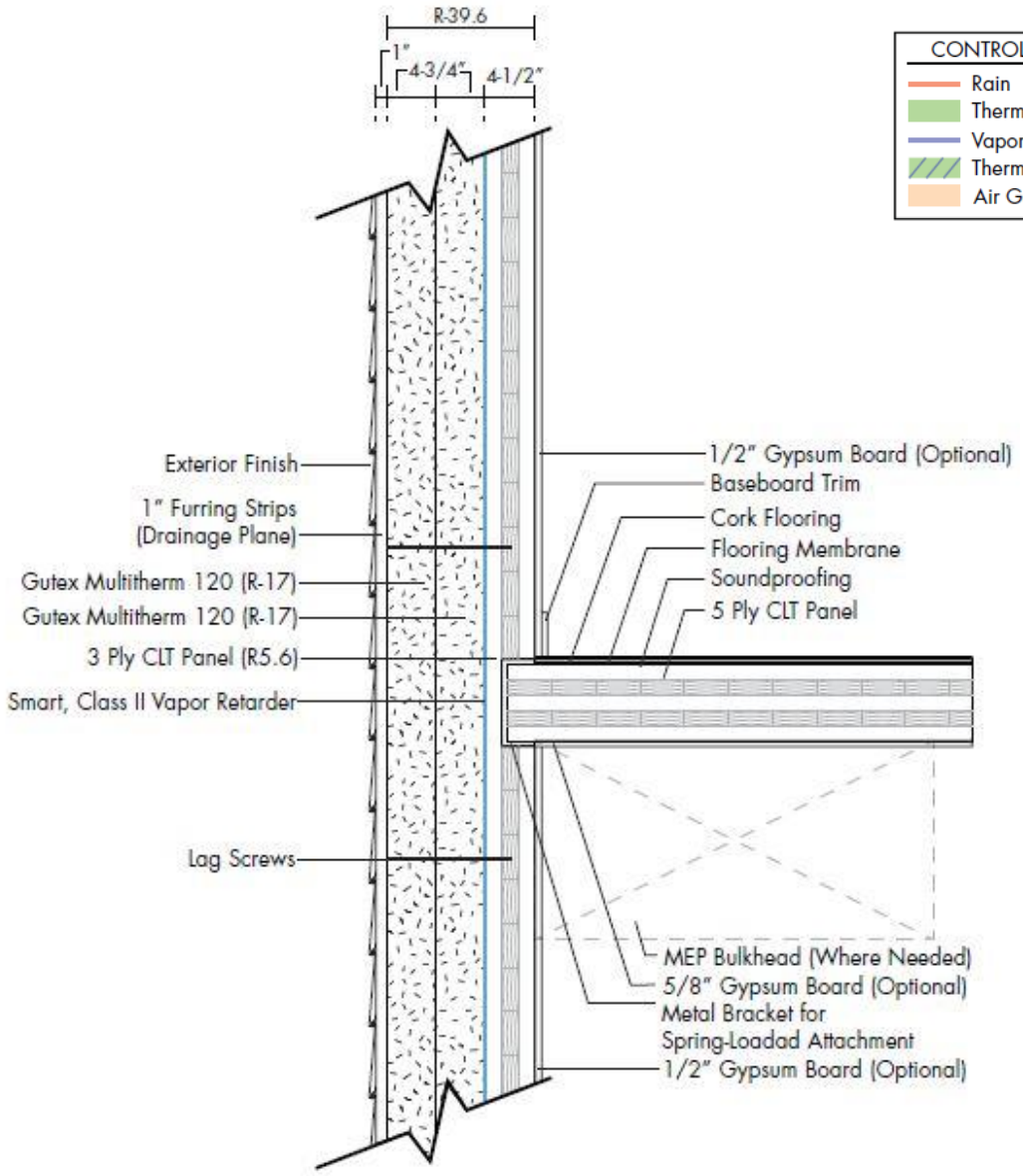
First Floor living space looking east toward kitchen

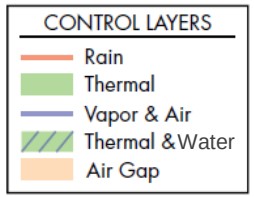
First Floor living space looking west

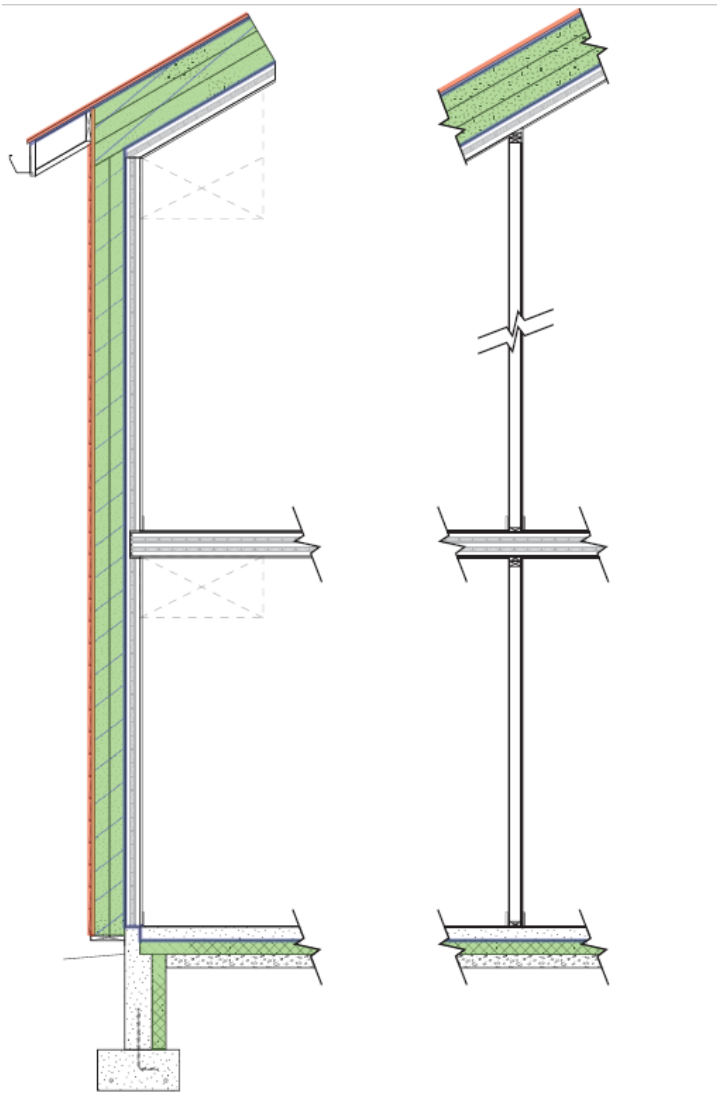
ENGINEERING

ENVELOPE

- **Exceeds PHIUS 2021 Prescriptive Path requirements**
- **R-39.6 Wall, R73.7 Roof**
- **Cross-laminated timber (CLT) construction**
- **Continuous Smart vapor retarder & air barrier**
- **Continuous wood fiber insulation with integrated WRB**
- **Drainage plane/air gap**
- **Low maintenance steel siding & standing seam roof**
- **Triple-pane windows (U-0.15)**
- **Insulated slab on grade (R-20)**







EXTERIOR SECTION

INTERIOR SECTION

EMBODIED ENVIRONMENTAL IMPACT

ENVIRONMENTAL IMPACT ANALYSIS

- **PHIUS+ Prescriptive pathway increased the use of insulation in the house**
- **Wood fiberboard insulation vs. foam insulation**
- **Increased the use of wood**

TRADE-OFFS

- **The use of the CLT and a dense amount of insulation has made it a very high-performance building envelope**
- **Lowered the energy usage of the house**
- **Allowed for all on-site energy production**

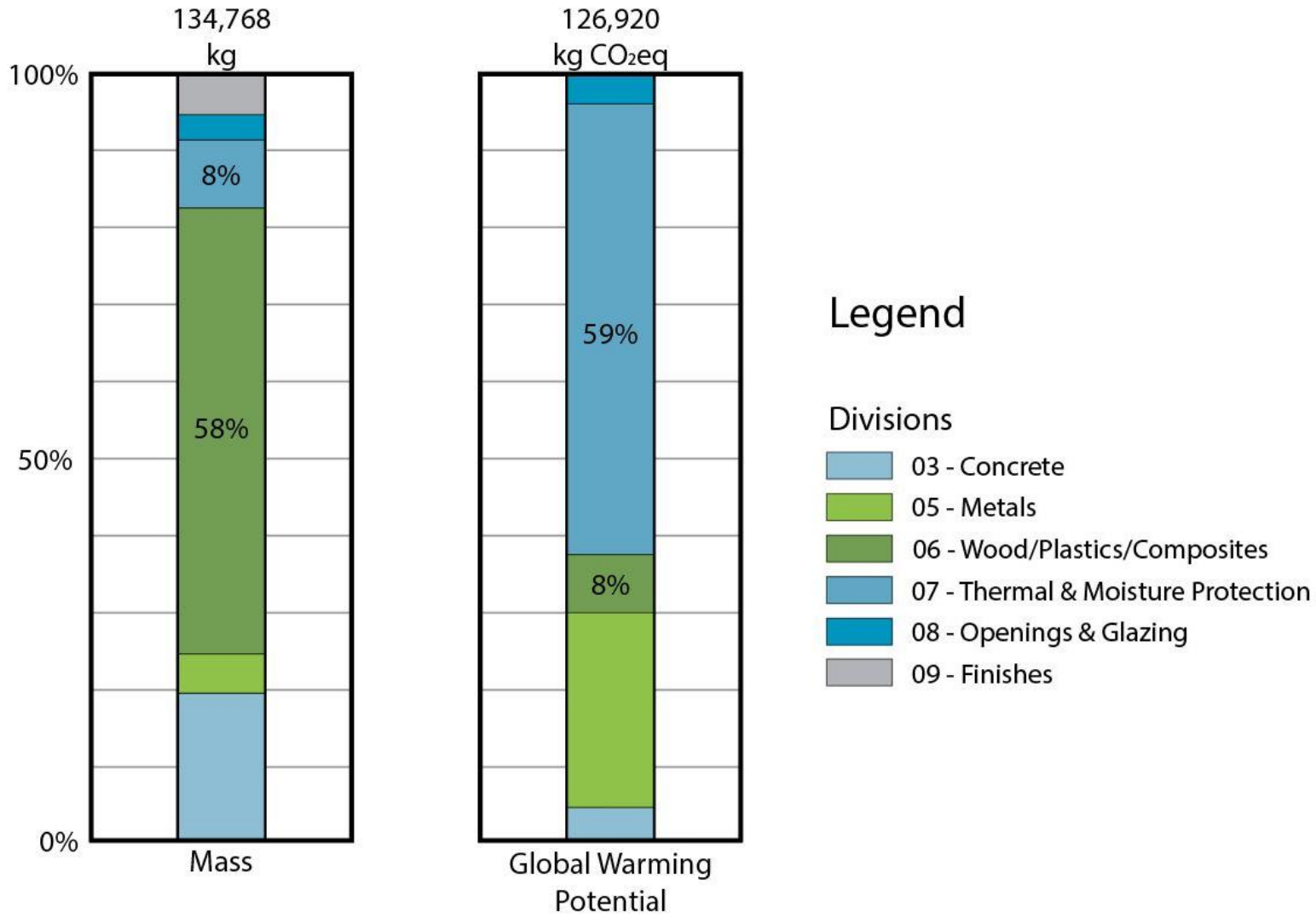


Figure: Tally analysis

COMFORT AND ENVIRONMENTAL QUALITY

HEATING AND COOLING SYSTEM

- **Variable Refrigerant Flow (VRF)**
  - Non-ducted system
  - Uses small refrigerant pipes
  - Services multiple zones

- **Why this type of system was chosen**
  - Each zone can be individually controlled to provide more thermal comfort to occupants
  - One system can provide both heating and cooling simultaneously
  - Efficient operation

VENTILATION SYSTEM

- **Energy Recovery Ventilator (ERV)**
  - Removes stale air and replaces it with fresh air

- **Why this type of system was chosen**
  - Efficient operation
  - Good moisture control
  - Quiet operation
  - Easy and quick installation and maintenance
  - Ease of use for occupants

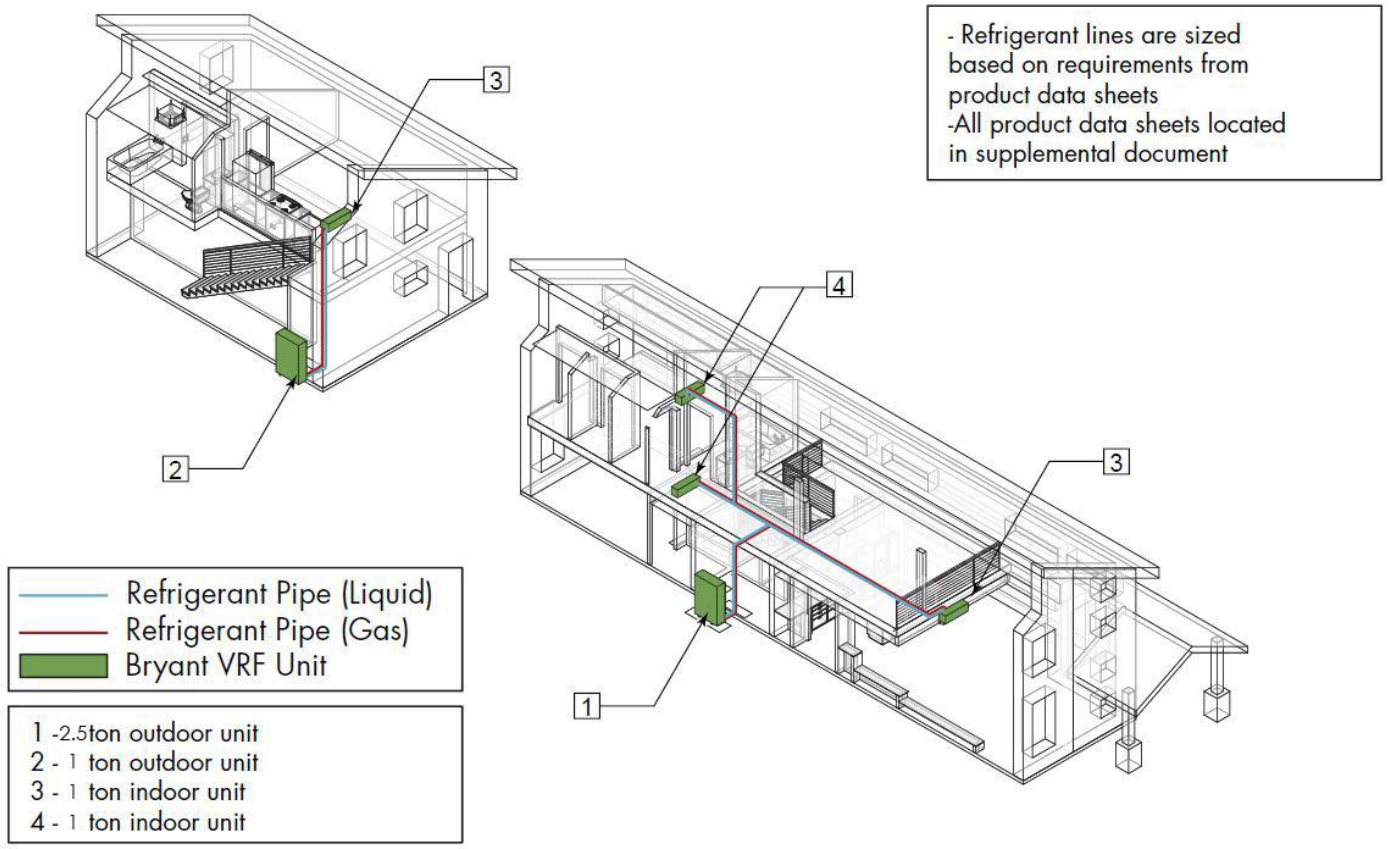


Diagram of VRF systems in the main house and ADU

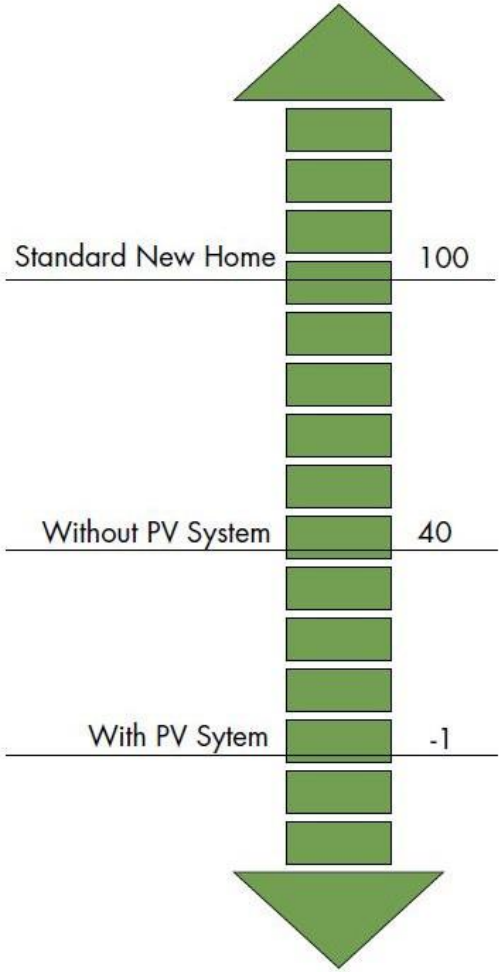
ENERGY PERFORMANCE

ENERGY USE INTENSITY (EUI)-kBtu/sf/yr

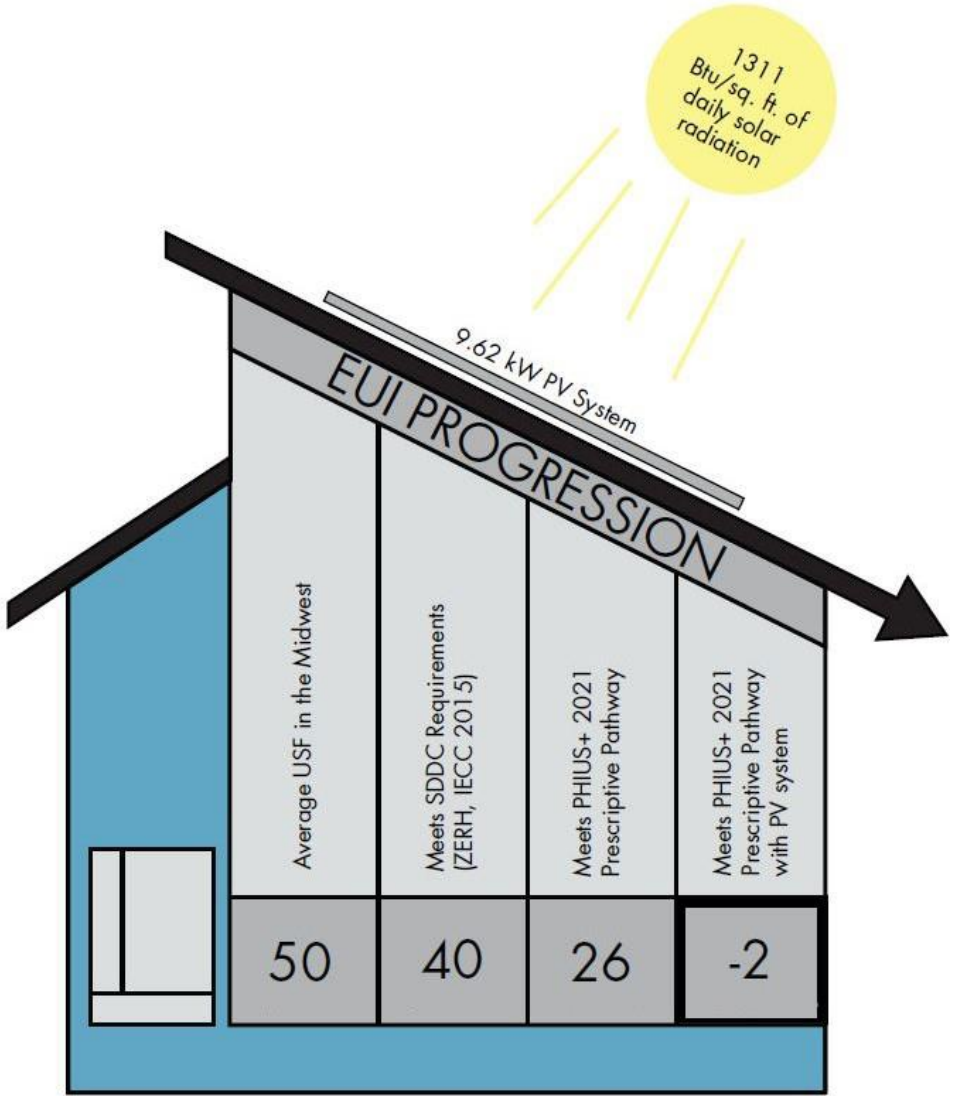
- Average single-family home has an EUI of 50
- Compliance with the DOE Zero Energy Ready Home (ZERH) Standard reduced the EUI to 40
- Compliance with the PHIUS 2021+ Prescriptive Path Standard reduced the EUI to 26.
- With a 9.62 kW solar array, the design has an EUI of -2 and is slightly net-positive
- Calculations done with BEopt

ENERGY RATING INDEX (ERI)

- ERI Used in lieu of a HERS rating
- Average new house in US has an ERI of 100
- Compliance with the PHIUS 2021+ Prescriptive Path Standard reduced the ERI to 40
- With a 9.62 kW solar array, the design has an ERI of -1 and is slightly net-positive
- Calculations done with BEopt



ERI Design Progression



EUI Design Progression

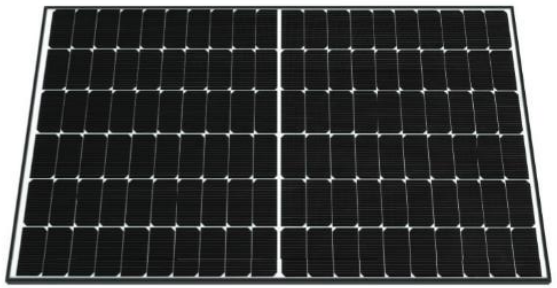
ENERGY PERFORMANCE

PHOTOVOLTAIC SYSTEM

- Panasonic EverVolt 370W
- 9.62 kW system (26 PV modules @ 370 Watts)
- 30-degree mounted flush with south facing roof
- 99% weighted efficiency

CALCULATIONS

- Est. 13,300 kWh/year or 45.38 MMBtu/year
- Extra space for additional future PV expansion
- Potential for 8 additional modules
- + SolarEdge HD Wave inverter and power optimizer



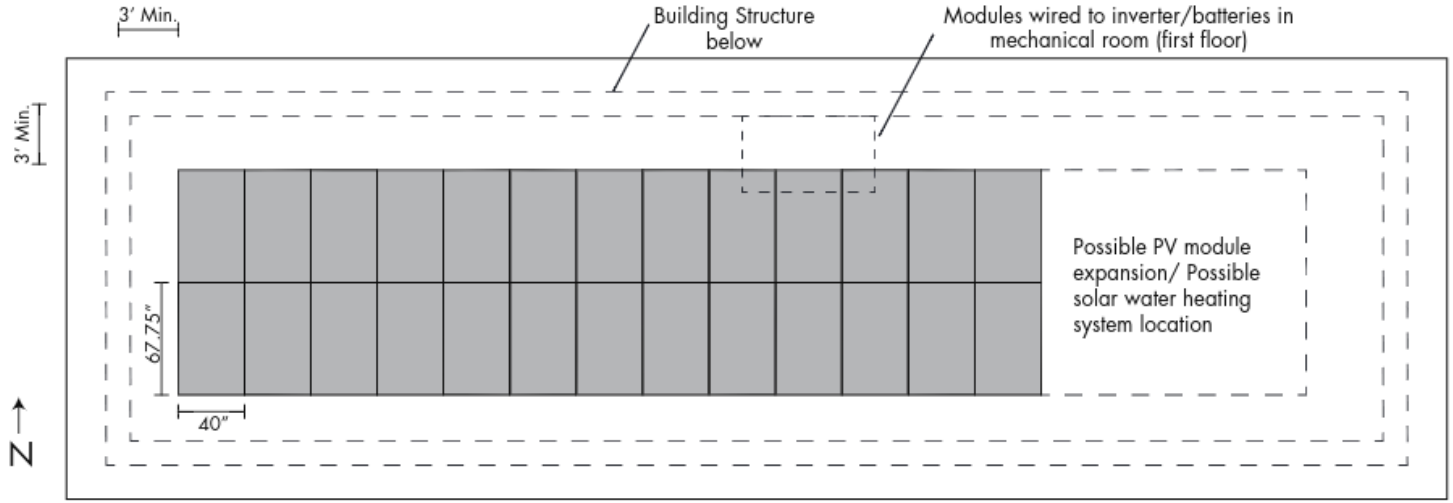
Panasonic EverVolt 370W panel

SOLAREDGE INVENTER AND POWER OPTIMIZER

- 3kW to 11.4kW range
- 99% weighted efficiency
- Internet connection
- 25-year warranty

PANASONIC EVERVOLT 370W

- 370-Watt module
- Module efficiency of 21.2%
- 25-year warranty
- Annual degradation of only 0.25%
- Operating temperatures from -40°F to 185°F



Rooftop layout of the PV array

CONCLUSION

PROJECT INDY: REIMAGINED

- **Aging in place**
- **Durability and resilience**
- **Infill housing**
- **Replicability**